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# Seasonal infection dynamic of tetraphyllidean cestodes in the ommastrephid squids from Galician waters

## Dinámica estacional de la infección por cestodos tetrafilídeos en los omastréfidos de aguas de Galicia

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ABSTRACT

The seasonal dynamic of cestode tetraphyllidean infection by the genus *Phyllobothrium* on the short-finned squids *Illex coindetii* and *Todaropsis eblanae* from fishing grounds off Galicia is described. Seasonal changes in parasite infrapopulation counts were evident in northern and southern fishing areas but varying depending on host source. In any case highest infection values were found in late winter at the time of large mature squids, whereas lowest (and even no parasite recruitment to the host populations) infection values were found in the summertime. This corresponding with abundant hatchings and paralarvae supported by peaks in upwelling and blooms in available food related to the upwelled Eastern North-Atlantic Central Water (ENACW).

RESUMEN

Este trabajo describe la dinámica estacional de las infecciones por cestodos tetrafilídeos del género *Phyllobothrium* en las potas *Illex coindetii* y *Todaropsis eblanae* capturadas en las áreas de pesca de Galicia. Se evidenciaron cambios estacionales en el número de las infrapoblaciones parásitas en las áreas de pesca del norte y del sur, aunque éstos variaron en función de la especie hospedadora. En cualquier caso, los niveles más altos de infección se produjeron al final del invierno coincidiendo con las potas grandes y maduras. Mientras, los valores más bajos de infección (incluso sin reclutamiento de los parásitos en las poblaciones hospedadoras), se encontraron en el verano, coincidiendo con el periodo de puesta y abundancia de paralarvas, relacionada con los picos de afloramiento y disponibilidad de alimento en la masa de Agua Central NorAtlántica (ACNA).

KEY WORDS: cestode, tetraphyllidean, *Phyllobothrium, Illex coindetii, Todaropsis eblanae.*
PALABRAS CLAVE: cestodo, tetrafilídeo, *Phyllobothrium, Illex coindetii, Todaropsis eblanae.*

## INTRODUCTION

Despite symbiotic relationships between adult tetraphyllidean cestodes and their elasmobranch final hosts have been largely studied, little work has been done on the larval procercoid and plerocercoid stages. This lack of information is especially evident with regard to the cephalopod hosts, in spite of the fact that tetraphyllidean larvae have been recovered and taxonomically iden-

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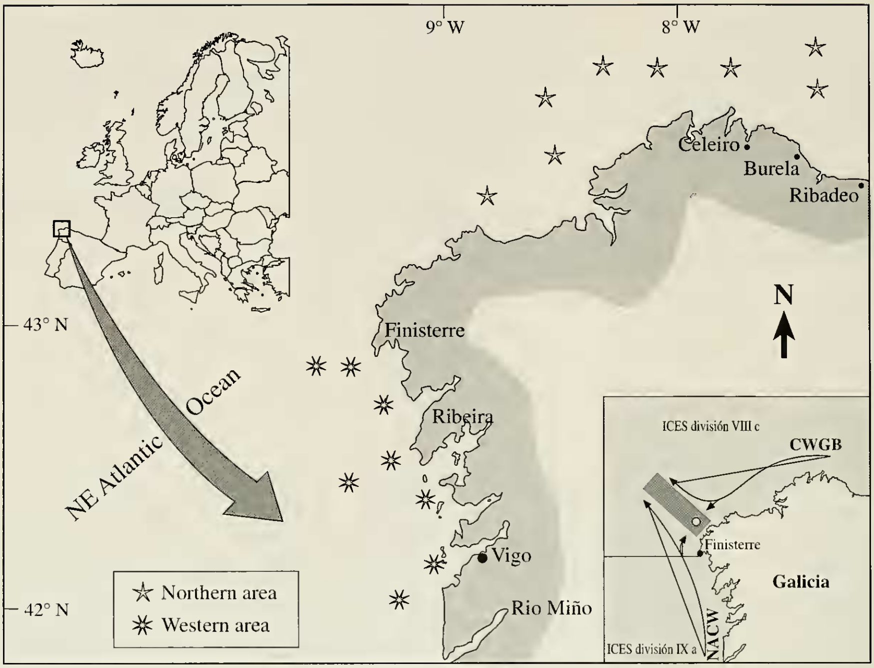


Figure 1. The location of sampling zones off Galician waters (NW Spain).
*Figura 1. Localización de las zonas de muestreo en las costas gallegas (NO España).*

tified from a wide diversity of coastal, neritic and/or oceanic squid, cuttlefish and octopus species worldwide (see review by HOCHBERG, 1990). Among this, only a few studies by Canadian, Russian and Spanish researchers (e.g., BROWN AND THRELFALL, 1968; BOWER, MARGOLIS AND YANG, 1990; NIGMATULLIN AND SHUKHGALTER, 1990; PASCUAL, GONZÁLEZ, ARIAS AND GUERRA, 1995a; PASCUAL, RASERO, ARIAS AND GUERRA, 1995b) have dealt with the demographic infection values and/or host-parasite relationships, but neither study provided a detailed account of the seasonal population dynamics of the infection in the wild, though this may be essential for a better understanding of the parasite recruitment and their ecological impact on wildlife cephalopod populations (PASCUAL, 1996).

In temperate waters off the NE Atlantic, relatively large ommastrephid samples were routinely available for study in commercial fisheries (GONZÁLEZ, RASERO AND GUERRA, 1996), thus providing an opportunity to describe the seasonal infrapopulation behavior of the plerocercoid tetraphyllideans in commercially-important ommastrephid squid populations.

## MATERIAL AND METHODS

At monthly intervals between 1992-1993, 1200 post-recruit of lesser flying squids *Illex coindetii* (Vérany, 1839) and broadtailed short-finned squids *Todaropsis eblanae* (Ball, 1841) (600 each) were collected by fishermen from local fishing grounds off Galicia (42° 5′ to 45° 15′ N, 7° to 9° 20′ W) (Fig. 1). Samples comprising 25 individuals per host species and sampling area were obtained from commercial landings in several ports within two hydrographically well-differentiated areas (FRAGA, MOURIÑO AND MANRÍQUEZ, 1982). The northern group consisted of all squids

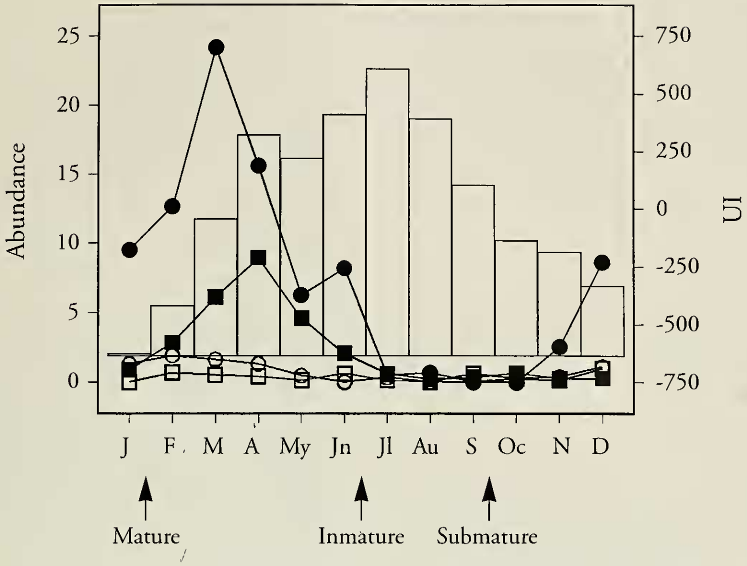


Figure 2. Monthly values in abundance of infection by *Phyllobothrium* spp. in squid at both sampling areas. (● ICN, *Illex coindetii* from the northern area; ○ ICS, *I. coindetii* from the southern area; ■ TEN, *Todaropsis eblanae* from the northern area; ❑ TES, *T. eblanae* from the southern area). Mature, immature and submature squids (i.e., condition of the gonad) was assessed using an universal maturity scale (LIPINSKY, 1979). The histogram represents the upwelling index (UI, expressed as m3s-1Km-1).

*Figura 2. Valores medios de infección por Phyllobothrium spp. en calamares de ambas áreas de muestreo. (● ICN,* Illex coindetii *del área norte ; ○ ICS,* I. coindetii *del área sur;* ■ *TEN,* Todaropsis eblanae *del área norte;* ❑ *TES,* T. eblanae *del área sur). La condición de la gónada de los calamares (maduro, inmaduro y submaduro) se ajusto usando una escala universal de madurez (LIPINSKY, 1979). El histograma representa el índice de afloramiento (UI, expressed as m3s-1Km-1).*

collected from Burela to Finisterre (ICES division VIIIc) and the southern group consisted of squids caught from Finisterre to Miño river (ICES division IXa). Each month, the viscera was removed from fresh dead squid and examined for larval tetraphyllidean cestodes. Seasonal differences among log-transformed parasite infrapopulation counts were compared using one-way ANOVA. To this end, data were analyzed on a quarterly basis: winter (January-March), spring (April-June), summer (July-September) and autumn (October-December). The abundance of infection (defined as the number of individuals of a parasite species in a host species regardless of whether or not the host is infected) was calculated each month for both host species and fishing areas as the most appropriate demographic infection value due to its population significance (BUSH, LAFFERTY, LOTZ AND SHOSTAK, 1997).

## RESULTS

In the northern area, a clear seasonal pattern of plerocercoid infection by *Phyllobothrium* van Beneden, 1850 larvae in both squid populations ($F= 23.56$; $p< 0.001$ for *I. coindetii*) ($F= 4.885$; $p< 0.05$ for *T. eblanae*) was observed (Fig. 2). Abundance of infection increased throughout the winter, reaching a maximum in late winter and early spring at the time of spawning. The highest infection values were found in the largest mature squids but declining towards the summer, when immature individuals are abundant. In the southern area, a significant seasonal variation was only found in the short-finned squid *I. coindetii* ($F= 5.89$; $p<0.05$). By the contrast, no seasonal variation in infection values ($F= 0.289$; $p=0.602$) was evident in *T. eblanae*. Nevertheless, the general pattern of seasonal parasite dynamic clearly suggests that infection is higher during colder months than during warmer months which is inversely correlated with the upwelling index, regardless of host source or sampling area.

## DISCUSSION

According with HOCHBERG (1990), plerocercoids of *Phyllobothrium* spp. in teuthoid cephalopods exhibit a marked ecological-specificity, i.e., they are more dependent on trophic levels occupied by the host species than on host phylogeny *per se*. The highest values of cestode infrapopulation counts during squid spawningtime herein reported, suggest that many species of selachians feed on the fast-moving squids mainly during the massive die-offs that occur following spawning. This clearly represents a synchronization of parasite and squid life-history strategies, in which the parasite utilizes the optimal stage of ontogenesis (i.e., trophic level) of the host to insure the maximum probability of entry into the final host. This pattern was also suggested by NIGMATULLIN AND SHUKHGALTER (1990) in the Patagonian squid *Illex argentinus* from 45-47°S but they observed no seasonal fluctuations among intraspecific groupings of similar size and maturity. In this way, the bimodal pattern of seasonal infection (highest during winter to springtime and lowest during summertime) herein reported, may be due to variations in squid size, age and/or maturity and ultimately to host feeding habits (PASCUAL, GONZÁLEZ, ARIAS AND GUERRA, 1996). In fact, the abundance of infection clearly increased with increasing host maturity over the entire life cycle, a characteristic common to many ommastrephid squids (BROWN AND THRELFALL, 1968; THRELFALL 1970; GAEVSKAYA AND NIGMATULLIN 1981; NIGMATULLIN AND SHUKHGALTER 1990; PASCUAL *ET AL.*, 1995a, b). Nevertheless, the abundance of infection did not increase with host maturity in the squids from the southern group which may be due to a lower overdispersion pattern of parasite infrapopulations than it accounted in the northern group. The effect of accumulation factor resulting from feeding patterns has been previously described in other trophically-transmitted cephalopod parasites by PASCUAL, GONZÁLEZ, ARIAS AND GUERRA (1999).

Otherwise, it is important to note that seasonal behavior of infection herein reported reflect variation in hydrographically-distinct sampling local areas of a single host species. In fact, regional variations (north-south) in the composition of the helminth fauna of both squid species has been also previously noted by PASCUAL *ET AL.* (1996). Despite the short distance between both sampling areas, these regions exhibit differences in oceanography, biological productivity, fauna composition, and diversity which may explain differences in infections values to the northern and southern mature squids. This clearly indicates that long-term sampling surveys should be carried out when comparing infection patterns in cephalopod populations, even at a microgeographic scale. Results also suggests that despite the influence of abiotic factors which could affect the infective free-living parasitic stages and thus their seasonal behavior, recruitment of worms to squid populations does not appear to be continuous. Infections were thus less abundant during late spring and summer, which coincided with the periodicity of host spawning for both squid species (GONZÁLEZ AND GUERRA, 1996) where hatchings and paralarvae are supported by peaks in upwelling and blooms in available food related to the upwelled Eastern North-Atlantic Central Water (ENACW) (ROCHA, GUERA, PREGO AND PIATKOWSKI, 1999). This type of periodicity appear similar to that described r-strategist organisms which have welldefined seasonal cycles in temperate waters of the world. Therefore, an ecological specificity based on host-related biotic factors rather than an oceanographic or host specificity is likely to be the caused of seasonal infection dynamic of tetraphyllidean cestodes of *Phyllobothrium* in the short-finned squids from Galician waters. Additionally, a wide distribution of both host and parasite clearly show the potential cosmopolitan character of the infection and the important role played by large, mature ommastrephids as second intermediate hosts for *Phyllobothrium* in temperate waters off the NE Atlantic.

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